PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H04J 3/02, 3/24, 15/00, H04Q 11/04, H04M 11/00, H04H 1/00, H04N 7/10

A1

(11) International Publication Number: WO 96/33562

(43) International Publication Date: 24 October 1996 (24.10.96)

(21) International Application Number: PCT/US96/05453

(22) International Filing Date: 19 April 1996 (19.04.96)

(30) Priority Data:
08/426,920 21 April 1995 (21.04.95) US

(71) Applicant: HYBRID NETWORKS, INC. [US/US]; 10201 Bubb Road, Cupertino, CA 95014 (US).

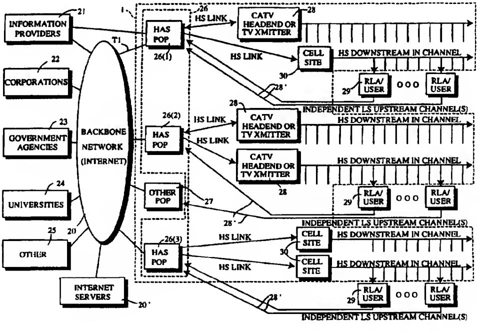
(72) Inventors: MOURA, Eduardo, J.; 3509 Mt. Davidson Court, San Jose, CA 95124 (US). GRONSKI, Jan, M.; 705 Newell Road, Palo Alto, CA 94303 (US).

(74) Agents: HARBIN, Lawrence et al.; Cushman Darby & Cushman, L.L.P., 1100 New York Avenue, N.W., Washington, DC 20005 (US).

(81) Designated States: JP, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
With amended claims and statement.

(54) Title: ASYMMETRIC HYBRID ACCESS SYSTEM AND METHOD



(57) Abstract

A hybrid access system and method using a hybrid access system point of presence router (26) and a remote link adapter (60) to connect a user computer terminal (2) to a network (20) for fast downstream information transfer by high speed information broadcasting with lower speed upstream information transfer through an independent upstream channel to the hybrid access system point of presence router. High speed downstream information transfer passes through a cable TV headend or a TV transmitter or a cell station (28).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgystan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic			SE	Sweden
CG	Congo	KR	Republic of Korea	SG	Singapore
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LR	Liberia	SZ	Swaziland
CS	Czechoslovakia	LT	Lithuania	TD	Chad
CZ	Czech Republic	LU	Luxembourg	TG	Togo
DE	Germany	LV	Latvia	TJ	Tajikistan
DK	Denmark	MC	Monaco	TT	Trinidad and Tobago
EE	Estonia	MD	Republic of Moldova	UA	Ukraine
ES	Spain	MG	Madagascar	UG	Uganda
FI	Finland	ML	Mali	US	United States of America
FR	France	MN	Mongolia	UZ	Uzbekistan
GA	Gabon	MR	Mauritania	VN	Viet Nam

ASYMMETRIC HYBRID ACCESS SYSTEM AND METHOD

Field of Invention

This invention relates to systems and methods for extending a high-speed network to remote locations using an asymmetric hybrid access system.

Background of the Invention

Current data communication systems typically use symmetric communication paths between transmit and receive sites, which have substantially the same data rates and use the same media in both directions. Such media may include coaxial, fiber optic, or telephone twisted-pair lines. Some networks alternatively use broadcast only paths. However, no current network combines the flexibility of full-duplex symmetric networks with the cost effectiveness of broadcast only networks.

Prior attempts at achieving asymmetric data communications included modems with very low speed return channels or systems combining a low speed broadcast channel with telephone return lines. However, no prior systems were able to extend a symmetric high-speed backbone network to remote locations at high speeds using an asymmetric hybrid access system. Known prior asymmetric systems are limited to low speed links.

It is desirable to develop a network which combines the flexibility of a full-duplex network with the effectiveness of a broadcast network at a reasonable cost.

Summary of the Invention

According to the present invention, a high speed backbone network is extended for communications with remote locations with a hybrid asymmetric architecture having fully interactive duplex characteristics and including independent upstream and downstream communication paths operable at separately selectable speeds and protocols. According to one embodiment of the present invention, the hybrid asymmetric architecture includes 6 Megahertz television channels downstream and telephone lines for upstream communications. Alternative downstream communications can be accomplished according to the invention with a selected high bandwidth broadband service, including for example high definition television (HDTV). Downstream communications according to another embodiment can be implemented with a selected low cost, high speed broadband modem. Downstream communications can provide access to data from information sources including companies, government agencies, universities, libraries, and the like. Alternative upstream communications can be accomplished by a narrow band cable TV return channel, ISDN, radio, or a selected low-cost, low to medium speed telephone modem. The asymmetric hybrid system according to the present invention includes an interface with the backbone network connected to selected information sources. The interface includes point of presence (POP) circuits implementing high speed downstream communications with lower speed upstream communications. The interface connects the backbone network with

cable TV head ends, TV transmitters, cell sites, remote users, and upstream and downstream channels.

The present invention further includes a hybrid access configuration which uses both downstream and upstream channels. The present invention further includes a hybrid access configuration which uses downstream wireless TV channels and upstream public switch telephone network (PSTN), wireless RF communications or integrated services digital network (ISDN) telephone lines. The present invention further includes a hybrid access configuration which uses both downstream and upstream cable TV channels. The present invention further includes a hybrid access configuration which has downstream satellite TV channels and upstream public switch telephone network (PSTN), wireless RF communications, or integrated services digital network (ISDN) telephone lines.

The present invention further includes packet and acknowledge suppression methods to eliminate redundant packet, byte, and acknowledge transmissions in a hybrid access system. A packet is defined as an information unit containing one or more bytes of information. Particularly according to the method of the present invention, a certain amount or number of data packets or bytes are enqueued or transmitted in a transmit-ahead window. Transmission of a window of bytes or packets is followed by a predetermined time-out period while the transmit queue awaits acknowledgments of packets received. To the extent receipt acknowledgments are received as to particular bytes or packets, these packets and bytes in the transmit queue will be deleted from the transmit queue, and the transmit queue is open to receipt of further packets or bytes for emplacement in slots of the transmission queue for the deletions made. With respect to acknowledgments placed in a transmission queue, indications acknowledging receipt of later bytes and packets supersede acknowledgments of earlier transmitted bytes or packets. Accordingly, under the present invention, the earlier acknowledgments are deleted from an acknowledge transmission queue.

The present invention further includes an automatic address allocation and configuration method in transmissions employing a hybrid access system. According to the present invention, remote users are identified initially with an abstract name, e.g., "Bob," and this abstract name is registered by the network management system. Configuration is established by the downstream routers polling the remote users and registering the location of the remote user responding to the poll made with the particular abstract name. Internet Protocol address and upstream channel allocation is accordingly accomplished subject to the configuration made including abstract name and identified location.

The present invention further includes a prioritized polling method in transmissions employing a hybrid access system. According to a method of the present invention, hybrid upstream routers poll client devices such as remote link adapters (i.e., "RLAs") according to predetermined priority levels. According to one embodiment of the present invention, priority levels are established for state categories of RLAs. According to one embodiment of the present invention, priority level states include status states such as idle, non-responsive, requesting

channel(s), active, or active-credit. According to one embodiment of the present invention, RLAs which request a channel are prioritized according to the amount of time its channel requests have gone unfulfilled. According to one embodiment of the present invention hybrid upstream routers poll downstream RLAs which are idle more frequently than non-responsive RLAs.

The present invention further includes an automatic gain adjustment technique in transmissions employing a hybrid access system, according to which a remote link adapter sends successive indications to a hybrid upstream router at selected different power levels. When a power level indication is received by a hybrid upstream router, the receiving hybrid upstream router confirms receipt of such indication to the sending remote link adapter which then registers an associated power level as qualified. According to one embodiment of the present invention, the selected different power levels are dynamically adjusted in magnitude of transmission level.

The present invention further includes a quality-based upstream channel allocation technique in transmissions employing a hybrid access system. According to the technique, the hybrid upstream router first determines the availability of upstream cable channels by a frequency agile RLA setting a wide range of narrowband upstream channels. The upstream router then makes a quality assessment of available channels in view of most recent demand, and it finally selects an upstream channel in view of the quality assessment made. Quality assessment includes determination of busy status and signal characteristics including error rates, noise floor, and signal to noise ratio. Upstream channels are releasable according to inactivity or time-out criteria, according to which release or reassignment occurs responsive to inactivity for over a threshold period. Inactivity is assessed by the hybrid upstream router monitoring operability indications and data packets received from assigned RLAs.

The present invention further includes a credit allocation technique in transmissions employing a hybrid access system. According to a method of the present invention, an upstream channel is shared by a plurality of RLAs in accordance with a credit criterion, and credit control packets are dispatched to a RLA which permit the RLA to send data packets to arbitrary hosts. Upon sending a data packet, the RLA returns the credit control packet to a server containing software including Hybridware™ code which manages data flows. The Hybridware™ code or Hybridware™ server, according to one embodiment of the present invention, includes software distributed among data processors in the upstream and downstream routers and elsewhere in the HASPOP, including for example in the network management system.

Description of the Drawings

Figure 1 is a detailed schematic drawing of a hybrid access system connected to a backbone network such as the Internet, and having points of presence connecting the backbone network to cable TV headends, TV transmitters, or Logical Nodes (e.g., cell sites), with remote users connecting to an RLA which in turn connects to downstream TV channels and independent lower speed upstream channels;

Figure 2a is a schematic drawing of a hybrid access system point of presence (POP) according to the present invention including at least a single host computer or server and at least a single router including a hybrid downstream router, a hybrid upstream router, a dial-up router, an Internet router, or a backbone network router, and a POP LAN switch;

Figure 2b is a block diagram of a downstream router according to the present invention;

Figure 2c is a block diagram of an upstream router according to the present invention;

Figures 3a, 3b, and 3c comprise a pictorial diagram of a hybrid access system according to the present invention according to which a remote user can communicate with an information provider through the hybrid access system;

Figure 4 is a logical data flow diagram showing data flows between a server and a client computer of the hybrid access system according to the present invention;

Figure 5 is a flow chart of operation of a two-way cable network embodiment of the hybrid access system according to the present invention;

Figure 6 is a flow chart of operation of a one-way cable network embodiment of the hybrid access system according to the present invention, including provision for upstream telephone system data flow;

Figure 7 is a Hybridware™ server state diagram of the upstream channel allocation method according to the present invention;

Figure 8 is a Hybridware™ client state diagram of the upstream channel allocation method according to the present invention;

Figure 9 is a logical data flow diagram showing data flows between router server and client computers of the hybrid access system for automatic handling of multiple clients according to automatic address allocation methods of the present invention;

Figure 10 is a flow chart of address allocation control protocol according to the present invention;

Figure 11 is a state diagram of the hybrid adaptive gain control protocol according to the present invention;

Figure 12a is a transmission diagram of information exchange between two nodes in an asymmetric network according to the present invention, having a high downstream data rate of n bits per second and a lower upstream data rate of m bits per second;

Figure 12b is a diagram of conventional downstream messaging of first through fourth data packets, 100, 250, 325, and 450, between first and second nodes, in parallel with upstream transmission of receipt acknowledge indications;

Figure 12c is a diagram of a conventional transmission buffer queue in a RLA of a remote client station;

Figure 12d is a diagram indicating a redundant acknowledgment packet in a conventional transmission buffer queue in a RLA of a remote client station;

Figure 12e is a diagram of a conventional transmission buffer queue, indicating no need for an earlier acknowledgment (ack 100) packet in view of a new acknowledgment (ack 210) packet that supersedes the earlier acknowledgment packet;

Figure 12f is a diagram of first through third network nodes serially connected to each other in accordance with the present invention, wherein the link between the first and second nodes is asymmetric and that between the second and third nodes is symmetric;

Figure 13 is a tabular description of transmission control protocol/ Internet protocol (TCP/IP) data transmission packet protocol header as used in connection with the present invention;

Figure 14a is a diagram of a sequential data transmission between first and second network nodes, according to the present invention;

Figure 14b is a diagram of the contents of a conventional transmission queue in the downstream node during a first time period;

Figure 14c shows the contents of a transmission queue in a downstream node during a later time period, eliminating retransmission of the 300 packet, according to the present invention, because another 300 packet was already in the transmission queue;

Figure 15 is a flow diagram of the acknowledge suppression method according to the present invention;

Figure 16 is a flow diagram of the packet suppression method according to the present invention;

Figure 17 is a flow diagram of information exchanges between Hybridware™ server and client, under conditions in which the client has no information to transmit;

Figure 18 is a flow diagram of information exchanges between Hybridware™ server and client, under conditions in which the client has information to transmit and the server gradually allocates bandwidth to the client;

Figure 19 is a flow diagram of information exchanges between Hybridware™ server and client, under conditions in which the server allocates the client a dedicated channel, the client transmits data and periodically reports to the server with done messages; and

Figure 20 is a flow diagram of information exchanges between Hybridware™ server and client, under conditions in which a dedicated channel is converted into a shared channel.

Description of the Preferred Embodiment

Figure 1 is a detailed schematic drawing of a hybrid access system 1 according to the present invention, showing a RLA and user workstation 29 connected through hybrid access system 1 to a variety of entities connected to a backbone network 20 such as Internet, including information providers 21, corporations 22, government agencies 23, universities 24, and others 25. A backbone network is one which is typically not directly connected to a user. Hybrid access system 1 according to an embodiment of the present invention includes hybrid access system (HAS) points of presence (POPs) 26 and other points of presence 27. HASPOPs 26

include individual HASPOPs 26 (1)-26(3) which enable communication over a broadband network, either by upstream and downstream cable communications or by downstream cable and upstream telephone communications or various other hybrid configurations (e.g., wireless or satellite). The present invention particularly includes (1) a hybrid access configuration which uses downstream cable TV channels and upstream public switch telephone network (PSTN), wireless RF communications or integrated services digital network (ISDN) telephone lines; (2) a hybrid access configuration which uses downstream wireless TV channels and upstream public switch telephone network (PSTN), wireless RF communications or integrated services digital network (ISDN) telephone lines; (3) a hybrid access configuration which uses both downstream and upstream cable TV channels; (4) a hybrid access configuration which uses both downstream and upstream wireless channels; and (5) a hybrid access configuration with downstream satellite channels and upstream PSTN, wireless RF communications or ISDN telephone channels.

Backbone network 20 such as the Internet which includes a plurality of Internet servers 20 connected to HASPOPs 26 each including a plurality of host computers and/or servers, collectively referred to as hybrid servers. Hybrid access system 1 further includes broadcast units such as, a cable television (TV) head end 28, independent upstream channels 28; and a RLA 29. U.S. Patent No. 5,347,304 (1994) assigned to Hybrid Networks, Inc., and describing an example of an RLA is hereby expressly referenced and incorporated herein in its entirety. An RLA may receive analog broadcast signals including encoded digital information which the RLA decodes and provides to a data terminal or computer. According to an embodiment of the present invention, the downstream flow of information proceeds from HASPOPs 26(1)-26(3) through cable TV head end or TV transmitters 28 or cell sites 30 and through RLA and user workstation 29. Upstream information flow proceeds in one case from RLA and user workstation 29 through independent upstream channels 28; to HASPOP 26(1), and then to backbone network 20; along T1 or T3 or other digital lines. In another case, upstream information proceeds from user workstation through RLA 29 through the cable TV network, and cable TV head end 28 to hybrid access system point of presence and then through T1, T3, or other digital lines to backbone network 20. The outputs of the cable TV headends or TV transmitters 28 include pluralities of high speed downstream broadband radio frequency, i.e., RF, channels connected to respective remote users 29. Hybrid access system 1 further includes a plurality of cell sites 30 connected through high speed links to a corresponding hybrid access system point of presence 5. The outputs of cell sites 30 include pluralities of high speed downstream broadband channels connected to selected remote users 29. A particular remote user 29 can be connected via an independent lower speed upstream channel to a hybrid access system point of presence 26 as discussed below or via a similar independent lower speed upstream channel to another point of presence system 27. By lower speed it is meant at a speed reduced from the speed of the high speed link used to transmit information downstream. A particular hybrid access system point of presence 5 can be connected via duplex high speed links to a

plurality of cable TV headends or TV transmitters, to a plurality of cell sites 30, or a combination of cable TV headends or TV transmitters 28 and cell sites 30.

Figure 2a is a schematic drawing of a point of presence (POP) system 26(1) according to the present invention, including host computers or servers 39 and a POP local area network, i.e., LAN switch 33 to which host computers or servers 39 are connected. Further connected to LAN switch 33 are one or more downstream and one or more upstream hybrid access system point of presence routers, respectively 34 and 35, one or more dial-up routers 36, a network management system 37, and conventional routers 38. Connected to POP LAN switch 33 are one or more data storage elements or systems. Each downstream hybrid access system point of presence router 34 is connected with a high speed link to a TV transmitter or cable TV headend, for example. Further, each upstream hybrid access system point of presence router 35 is connected to a plurality of independent upstream channels, which operate at a lower speed than the downstream high speed links to TV transmitters or cable TV headends. Each dial-up router 36 is connected to a plurality of independent upstream channels operating at a lower speed than the indicated downstream high speed links. Each conventional router 38 is connected along a high speed line to wide area network (WAN) lines to selected information providers, Internet, or other nodes or businesses. POP LAN switch 33, according to one embodiment of the present invention is connected directly along a high speed line to wide area network (WAN) lines to selected information providers, Internet, or other nodes or businesses.

Figure 2b is a block diagram of hybrid downstream router 34 according to the present invention. In particular, downstream router 34 includes network interface 34a, link interface 34b, physical interface 34c, controller 34d, physical interface 34e, link interface 34f, and network interface 34g. Downstream router 34 and physical interface 34e are connected to POP LAN switch 33 for sending and receiving information, and physical interface 34e, link interface 34f, and network interface 34g are serially connected to each other and to controller 34d for bidirectional communication of selected information. Additionally, controller 34d is connected directly to each of physical interface 34e and link interface 34f along indicated lines to accomplish control and messaging functions. Downstream router 34 and physical interface 34c are connected to cable TV headends, TV broadcast sites, cell cites or the like, to communicate information primarily or exclusively in a unidirectional or downstream direction, and physical interface 34c, link interface 34b, and network interface 34a are serially connected to each other and to controller 34d for selected communication of selected information. Additionally, controller 34d is connected directly to each of physical interface 34c and link interface 34b along indicated lines to accomplish control and messaging functions. Downstream router 34 may include one or more of physical interfaces 34c. According to an embodiment of the present invention, router 34 may be a bridge without network interfaces 34a and 34g or a connection without network interfaces 34a and 34g and without link interfaces 34b and 34f. According to yet another embodiment of the present invention, router 34 can be a gateway.

Figure 2c is a block diagram of upstream router 35 according to the present invention. In particular, upstream router 35 includes network interface 35a, link interface 35b, physical interface 35c, controller 35d, physical interface 35e, link interface 35f, and network interface 35g. Upstream router 35 and physical interface 35e are connected to POP LAN switch 33 for sending and receiving information, and physical interface 35e, link interface 35f, and network interface 35g are serially connected to each other and to controller 35d for bidirectional communication of selected information. Additionally, controller 35d is connected directly to each of physical interface 35e and link interface 35f along indicated lines to accomplish control and messaging functions. Upstream router 35 and physical interface 35c are connected to upstream channels, e.g., telephone links for example, to communicate information primarily or exclusively in a unidirectional or upstream direction, and physical interface 35c, link interface 35b, and network interface 35a are serially connected to each other and to controller 35d for selected communication of selected information. Additionally, controller 35d is connected directly to each of physical interface 35c and link interface 35b along indicated lines to accomplish control and messaging functions. Upstream router 35 may include one or more of physical interfaces 35c. According to an embodiment of the present invention, router 35 may be a bridge without network interfaces 35a and 35g or a connection without network interfaces 35a and 35g and without link interfaces 35b and 35f. According to yet another embodiment of the present invention, router 35 can be a gateway.

Figure 3a-3b are drawings of a hybrid access system 1 according to the present invention according to which remote user having a workstation 2 or connected to LAN 61, as shown respectively in Figures 3b and 3c can communicate with a selected information provider 21 including LAN 50, bridge or router 51 connected to LAN 50, and dial-up router 52 connected to LAN 50 through a hybrid access system point of presence 5. Further, HAS POP is connected along a high speed link to bridge or router 51. Additionally, HAS POP 5 is linked to other information providers to receive selected information items. Additionally, dial-up router 52 is connected to a plurality of upstream channels. Figure 3b and 3c additionally show respective first and second users, in one case including workstation 2 in turn including a RLA 60 and in the other instance including RLA 60 and a local area network (LAN) 61 connected to RLA 60. First user 29(1) is connected to an upstream channel from user workstation 2, and second user 29(2) is connected to an upstream channel directly from RLA 60. In the case of each user, RLA 60 receives input information, particularly radio frequency (RF) information along one of respective input channels connected thereto.

Figure 4 is a logical data flow diagram showing data flows between a server and a client computer of the hybrid access system 1 according to the present invention. Hybrid access system 1 includes a server application 70, a hybrid system manager 71, and a Hybridware™ server 72 connected to LAN 38. Hybrid access system 1 further includes a Hybridware™ client 73 and a client application 74 operating with Hybridware™ client 73. Hybridware™ client 73 communicates with Hybridware™ server 72, as transmitter along upstream channel 75 or as

receiver along downstream channel 76. Downstream data traffic is expected to be higher capacity than upstream data traffic: Hence, the bolder depiction of downstream channel 76 than upstream channel 75.

Figure 5 is a flow chart of operation of a two-way cable network embodiment of hybrid access system 1 according to a hybrid protocol embodiment of the present invention. In particular, according to one embodiment of the hybrid protocol of the present invention, client application 74 sends 100 data to server application 70 in an upstream direction, thereby issuing a connection request. Hybridware™ client 73 buffers the data received and checks if it controls an upstream data channel. If it does, then the data is transmitted forthwith. If it doesn't, Hybridware™ client 73 queues up the data message and creates 101 a channel request for a particular subchannel within upstream channel 75. Hybridware™ client 73 then waits 102 for a poll from Hybridware™ server 72, i.e., Hybridware™ router. According to an embodiment of the present invention, prioritized polling is conducted whereby not all clients are polled at the same frequency. Clients in an idle state are polled relatively frequently. Clients in blocked and NON-RESP states are polled but not at the same relatively high frequency. Clients in an ACTIVE state are not polled at all. This is based on the assumption that an active client has what it wants and that it is most important to respond quickly to new connections coming from clients in an IDLE state. Those clients coming from a NON_RESP cycle receive second order attention and can wait a little longer, since they may have already been in a state where communication are impossible and may have been in that state for a considerable period of time. According to one embodiment of the present invention, a poll cycle is the smallest period such that all but active clients are polled at least once. Idle clients may be polled multiple times during one poll cycle. Blocked and non_resp clients are distributed evenly across the poll cycle to assure that the latency for acquiring a channel for idle units is uniform. All clients are grouped according to their state and polled within each group according to the round robin approach according which each of a series is polled in sequence and then the same sequence is repeatedly polled individual by individual. Upon receipt of a poll, Hybridware™ client 73 sends 103 a channel request via lower speed upstream channel 75. Hybridware™ router 72, i.e., server, receives 104 the channel request from Hybridware™ client 73 and initially sends 105 a login message to Hybridware™ system manager 71. Hybridware™ system manager 71 verifies 106 that Hybridware™ client 73 is an authorized user of data processing services on the particular node or system within which hybrid access system 1 operates. Then, Hybridware™ router 72 receives 107 a login response message from Hybridware™ system manager 71 through LAN 38, which indicates whether the client is allowed to operate on the particular network and which contains other operating characteristics of Hybridware™ client 73. Hybridware™ router 72 then allocates 108 (see state diagrams of Figures 7 and 8) an upstream channel 75 for Hybridware™ client 73, depending on channel availability and suitability. Suitability depends on factors including but not limited to channel quality, type of service required, operating characteristics of Hybridware™ client 73, configuration restrictions, and the like. Hybridware™ router 72 sends

109 an upstream channel allocation message to Hybridware™ client 73 via high speed downstream channel 76, which may according to one embodiment of the present invention specify the frequency on which Hybridware™ client 73 is permitted to transmit. Thereafter, Hybridware™ client 73 receives 110 an upstream channel allocation. Next, Hybridware™ client 73 tunes 111 to the specifically allocated upstream data channel frequency on which it is permitted to transmit data. Finally, Hybridware™ client 73 sends 112 the selected application data from client application 74. Accordingly, client application 74 and server application 70 are able to send and receive 113 data via upstream bandwidth management of an asymmetric hybrid access system, according to the present invention.

Figure 6 is a flow chart of operation of a one-way cable network embodiment of the hybrid access system 1 according to the present invention, including provision for upstream telephone system data flow. According to this embodiment of the present invention, when client application 74 needs to communicate with server application 70 in an upstream direction, Hybridware™ client 73 dials 202 Hybridware™ router 72. Then, Hybridware™ client 73 sends 203 a channel request via lower speed PSTN upstream channel (not shown). Hybridware™ router 72 receives 204 the channel request and sends 205 a login message to Hybridware™ system manager 71. Hybridware™ system manager 71 verifies 206 Hybridware™ client 73 as an authorized user. Then, Hybridware™ router 72 receives 207 a login response from Hybridware™ system manager 71. Hybridware™ router 72 sends 208 an authorization message to Hybridware™ client 73 via high speed downstream channel 76. Hybridware™ client 73 receives 209 the authorization message for use of a selected upstream PSTN channel. Finally, Hybridware™ client 73 sends 212 the selected application data. Accordingly, client application 74 and server application 70 are able to send and receive 213 selected data via the asymmetric hybrid access system 1.

Figure 7 is a Hybridware™ server state diagram for upstream channel allocation of the hybrid access system according to one embodiment of the present invention. According to the state diagram of Figure 7, the Hybridware™ server can be in one of four states: IDLE 301, NON_RESP 304, BLOCKED 302, or ACTIVE 303. In the IDLE state, the Hybridware™ server expects an IDLE poll response. If there is no request to the client from the application or a channel request message, or if there is application data that needs to be sent in the upstream direction. Upon receiving a channel request message, the server transitions the client to a BLOCKED state. In a BLOCKED state, the server sends one of two messages to the client, a channel allocation message or a no channel available message. Upon sending a channel allocation message, the server transitions the client to an ACTIVE state. Upon sending a no channel available message, the client remains in a BLOCKED state. The client will remain in the BLOCKED state until either a channel becomes available in which case the server will transition the client to the ACTIVE state or the server receives a channel release message in which case the server will transition the client to the IDLE state. In the ACTIVE state, the server does not poll the client. The server transitions the client from ACTIVE to IDLE upon receiving

a channel deallocation message or upon detecting a system defined inactivity time-out. In the ACTIVE state, the server waits for a periodic heartbeat message from the client. The Hybridware™ server software awaits periodic heartbeat messages from the client at selected time intervals. The server software monitors other channel quality parameters including errors and signal to noise ratios. If the server stops hearing a certain number of operability indications or signals within a system defined interval as to a particular client, or if particular parameters (e.g., signal to noise ratio), then the server send a directed poll to the particular client. Essentially, the client is instructed to respond on another control frequency. If the client responds on the designated control frequency, the server reassigns the upstream channel to the client, so that it can continue to operate. If not, the client is deemed NON_RESP. Channel quality monitoring and channel reassignments are done transparently to the user and the applications. If a certain, system defined, consecutive count of heartbeat messages is missed, the server issues a special poll message or directed poll. If the client does not respond, the server transitions to the NON_RESP state. If the client responds to the poll, the server either remains in the ACTIVE state or transitions to the IDLE state. The former happens, if the client responds with a channel request message, and the latter happens, if the client responds with an IDLE poll response. In the former case, the server may decide to assign a different upstream channel to the client. In the BLOCKED or IDLE state, the server will transition the client to NON_RESP, i.e., "non-responsive," state after the client fails to respond to a system defined number of polls. The NON_RESP state is almost identical in terms of state transition to idle state, a difference being that an IDLE poll response transitions the client into an IDLE state.

Figure 8 is a Hybridware™ client state diagram for upstream channel allocation of the hybrid access system 1 according to an embodiment of the present invention, involving two way cable communication. According to this embodiment, the hybrid upstream client protocol has three states, IDLE 401, CON_REQ, i.e., "connect request" 402, and ACTIVE 404. In the IDLE state, the client, when polled, will transmit an IDLE poll response, if there is no request from the application. However, it will respond with a channel request message, if there is data that needs to be sent upstream. Upon transmitting a channel request message, the client transitions to a CON_REQ state. In the CON_REQ state, the client expects one of two messages from the hybrid router, a channel allocation or a no-channel allocation signal. Upon receiving a channel allocation message, the client informs the application and tunes to the channel it was allocated and transitions to the ACTIVE state. Upon receiving a no-channel available message, the client informs the application and transitions to the IDLE state. In the ACTIVE state, the client forwards data messages from the application to the upstream transmitter. In the ACTIVE state, the client further monitors the application activity and if it detects that no data has moved from the application to the upstream transmitter for a system defined period of time, it will send a channel deallocation request and transition to an idle state. In an ACTIVE state, the application may explicitly request that the channel be released, in which case the client will send a channel deallocation request to the hybrid router and will transition to the IDLE state. In the ACTIVE

state, the client periodically sends an operability indication message to the server. If the client receives a poll message during the ACTIVE state, it will send a channel request message and will transition to a CON_REQ state. The hybrid router may also send an unsolicited channel release message, in which case the client will notify the application and transition from ACTIVE state to IDLE state.

Figure 9 is a logical data flow diagram showing data flows between server and client computers of the hybrid access system 1 according to the present invention, for multiple clients under an address allocation protocol simplifying distribution of ip addresses to remote systems. The protocol according to the present invention determines where a given Hybridware™ client is located and how to download its ip address, given that the client has no address yet. Hybrid access system 1 includes a server application 70, a hybrid system manager 71, and Hybridware™ servers 72a & 72b connected to LAN 38. Hybrid access system 1 further includes Hybridware™ clients 73a and 73b and client applications 74a and 74b operating with respective ones of Hybridware™ clients 73a and 73b. Hybridware™ client 73a communicates with Hybridware™ server 72a, as transmitter along upstream channel 75a or as receiver along downstream channel 76a. Hybridware™ client 73b communicates with Hybridware™ server 72b, as transmitter along upstream channel 75b or as receiver along downstream channel 76b. Downstream data traffic is expected to be higher capacity than upstream data traffic: Hence, the bolder depiction of downstream channels 76a and 76b than upstream channels 75a and 75b.

Figure 10 is a flow chart of address allocation control according to an embodiment of the present invention to logon and configure Hybridware™ clients with a selected unique node name which is entered in the configuration database in the hybrid system manager 71 which is the software portion of network management system 37. In particular, hybrid system manager 71 sends 500 a new client message to all hybrid routers 72a and 72b after learning of particular new clients by message, mail, or telephone call. At this point the hybrid system manager is aware of a Hybridware™ client identification name and equipment serial number, but has not associated the client identification name with a separate unique client address (e.g., Internet Protocol, or IP address) provided by separate automatic registration. Each hybrid router 72a and 72b periodically broadcasts 501 a configuration poll message. Hybridware™ clients recognize 502 their preselected unique names during a configuration poll. Hybridware™ clients 72a and 72b respond to the configuration poll. Hybrid routers 72a and 72b receive respective configuration poll responses. Then, hybrid routers 72a and 72b send respective client found messages to system manager 71. System manager 71 then sends a cease configuration poll message to all hybrid routers. Further, system manager 71 allocates an Internet protocol (IP) address and other configuration data for each new client according to the preselected unique names. System manager 71 sends the IP address and other configuration data to the applicable hybrid router 72a, 72b. Then, the applicable hybrid router 72a, 72b sends using broadcast or unicast and the unique name the corresponding IP address and other configuration data to the applicable Hybridware™ client. As a result, the Hybridware™ client receives the IP address and other configuration data

determined and reconfigures appropriately. In summary, according to the present invention, an automatic address allocation and configuration method in transmissions employs a hybrid access system. Remote users are identified initially with a unique abstract name, e.g., "Bob," and this abstract name is registered by the network management system. Configuration is established by the upstream routers polling the remote users and registering the location of the remote user responding to the poll made with the particular abstract name. Upstream channel allocation is accordingly made subject to the configuration made including abstract name and identified location. Automatic address allocation and configuration is accordingly accomplished on line at an initial log-on session with a new user. The method of the present invention is accordingly swift and simple, eliminating registration relays experienced by many known log-in systems.

Figure 11 is a state diagram of the hybrid adaptive gain control protocol according to the present invention, which overcomes noise and attenuation while transmitting on cable in an upstream direction. The hybrid adaptive gain control protocol has a searching state 600 and a stable state 601. In stable state 601, the protocol evaluates poll messages from the hybrid router. If a poll message indicates loss of a poll response, the protocol transitions to the searching state 600. Poll responses are transmitted at a fixed power level. In the searching state 600, the client system responds to polls with a poll response at larger and larger power levels. After receiving a system specified, number of consecutive polls with an indication of a successful poll response, the system transitions to a stable state.

Figure 12a is a transmission diagram of information exchange between nodes A and B. Nodes A and B comprise an asymmetric network according to the present invention, having a high downstream data rate of n bits per second and a lower upstream data rate of m bits per second. The downstream data rate n is greater than the upstream data rate m. Node B includes receive and transmission queues to hold information received and to be sent, including acknowledge indications or messages. The acknowledge suppression method according to the present invention relates to the node or system transmitting data acknowledgments, which acknowledges receipt of either data packets or data bytes contained in incoming packets. The numbers on data packets indicate the position of the last data byte of the packet in the data stream, and the acknowledgment numbers indicate that all the bytes of the data stream up to and including the byte indicated have been received. According to the method of the present invention, the acknowledgment of byte k (or packet number k) indicates that all bytes or packets prior to k have been received. According to a method of the present invention, the transmit queue queues up additional acknowledgment packets as new packets are received. Figure 12b is a diagram of messaging of first through fourth data packets, 100, 250, 325, and 450, between upstream and downstream nodes, in parallel with upstream transmission of receipt acknowledge indications with respect to only two data packets, namely 250 and 450. Figure 12c is a diagram indicating acknowledgment of first and second packet receptions during a first time period. In particular, packet 1 (i.e., "pkt 1") is currently being sent, and an acknowledge (i.e., "ack 250") message is currently being appended at the end of the transmit queue. Figure 12d is a diagram

indicating acknowledgment of another packet during another period. Figure 12e is a diagram indicating no need for an acknowledge 100 signal in view of a prior acknowledgment having been successful. In particular, according to the acknowledge suppression method of the present invention, not all acknowledgment packets will be sent to node A, because the "ack 210" message carries information which supersedes the "ack 100" message. Accordingly, the amount of traffic on the communication link from B to A is reduced, according to the present invention. In general, this introduces an acknowledge latency , but where all messages queued up for transmission are acknowledgments, acknowledgment latency is reduced. For example, when an "ack 15" signal is transmitted and an "ack 100" message awaits transmission, and an "ack 210" message is appended to the queue, the acknowledge suppression method according to the present invention will delete the "ack 100" message as superfluous. Any new acknowledgments appended while "ack 15" is being transmitted will result in deletions of unnecessary acknowledgments keeping queue length to two. Upon transmit completion of "ack 15," the next acknowledgment, e.g., "ack 210" will be transmitted. Accordingly, the method of the present invention eliminates unnecessary transmission of "ack 100" signals and provides for reduced acknowledgment latency for "ack 210." The ack suppression method according to the present invention, accordingly reduces the probability of queue overflow and potential out of memory conditions in system B. It reduces the load on the communication link from B to A, and in some circumstances reduces acknowledgment latency for data transfers from B to A. Figure 12f is a diagram of first through fourth network nodes serially connected to each other in accordance with the present invention, wherein the link between the first and second nodes is symmetric, the link between the second and third nodes is asymmetric and that between the third and fourth nodes is symmetric. The acknowledge suppression method of the present invention applies to both the communications system of Figure 12a, in which nodes A and B are end nodes, as well as to the communications system of Figure 12f, in which nodes B and C are intermediate systems such as a router, and data packets originating at node D are transmitted through router nodes C and B to a central system connected to node A.

Figure 13 is a tabular description of a transmission control protocol/ Internet protocol (TCP/IP) data transmission packet protocol header as used in connection with the present invention. The first five 32 bit words and the following IP options are referred to as the IP header. The five words following the IP options together with the words containing TCP options are referred to as the TCP header. The non-ack TCP header is the TCP header less the acknowledgment number field.

Figure 14a shows sequential data transmission between first and second nodes, according to the present invention. As shown in Figure 14a, data packets or bytes 100-700 are transmitted from node A to node B. Concomitantly, acknowledge messages, "ack 100," "ack 200," and "ack 300," were dispatched from node B to node A.

Figure 14b shows a data packet sequence of packets 100-400 held in the transmit queue during a first time period, followed by a single acknowledgment, "ack 100."

Figure 14c is a diagram of a data packet sequence transmitted during a later time period, eliminating retransmission of the 300 packet, because another 300 packet was already in the transmission buffer.

Figure 15 is a flow diagram of an acknowledge suppression (AS) method, i.e., an AS method, according to the present invention in which receipt of information transmitted from system A to system B over a first independent simplex communication link is acknowledged by system B. The method of the present invention starts 1500 at a particular time, and a first packet Mi of information is received 1501. If the transmit queue is not empty 1502, the header of the last packet Mi+1 on the transmit queue is obtained 1503. If the transmit queue is empty 1502, then Mi is enqueued 1509 and the AS method according to the present invention is completed. If the header of the last packet Mi+1 on the transmit queue equals 1504 the header of packet Mi, and the NON-ACK TCP header of Mi equals 1505 the NON-ACK TCP header of Mi, then Mi+1 is discarded 1506. If the header of the last packet Mi+1 on the transmit queue does not equal 1504 the header of packet Mi, or the NON-ACK TCP header of Mi does not equal 1505 the NON-ACK TCP header of Mi, then Mi is enqueued 1509 and the AS method according to the present invention is completed. If Mi+1 is not the last message on the queue 1507, then the header on the next packet Mi+1 on the transmit queue is obtained 1508, and a comparison is done to determine whether the header of the last packet Mi+1 on the transmit queue equals 1504 the header of packet Mi. If Mi+1 is the last message on the queue 1507, then Mi is enqueued 1509 and the AS method according to the present invention is completed.

Figure 16 is a flow diagram of the packet suppression (PS) method according to the present invention. The method of the present invention starts 1600 at a particular time, and a first packet Mi of information is received 1601. If the transmit queue is not empty 1602, the header of the last packet Mi+1 on the transmit queue is obtained 1603. If the transmit queue is empty 1602, then Mi is enqueued 1609 and the PS method according to the present invention is completed. If the header of the last packet Mi+1 on the transmit queue equals 1604 the header of packet Mi, then Mi+1 is discarded 1606. If the header of the last packet Mi+1 on the transmit queue does not equal 1604 the header of packet Mi, then Mi is enqueued 1609 and the PS method according to the present invention is completed. If Mi+1 is not the last message on the queue 1607, then the header on the next packet Mi+1 on the transmit queue is obtained 1608, and a comparison is done to determine whether the header of the last packet Mi+1 on the transmit queue equals 1604 the header of packet Mi. If Mi+1 is the last message on the queue 1607, then Mi is enqueued 1609 and the PS method according to the present invention is completed.

Figure 17 is a flow diagram of information exchanges between Hybridware™ server and client, according to conditions in which the client has no data to transmit. A credit (1, F) corresponding to a predetermined amount of data, e.g., ten bytes, or ten packets, is transmitted from node A to node B, and a done signal DONE(0,0) is transmitted from node B to node A, indicating that no data packet was transmitted, leaving the existing credit level of the particular

channel unchanged. The credit protocol according to the present invention permits single upstream cable channels to be shared by multiple remote link adapters. Alternatively, a single upstream channel is controlled and used by a single remote link adapter until the channel is relinquished. The present invention includes an allocation method in transmissions employing a hybrid access system. According to a method of the present invention, an upstream channel is shared by a plurality of remote link adapters in accordance with a credit criterion, and credit control packets are dispatched to a remote link adapter which permit the remote link adapter to send data packets to arbitrary hosts. Upon sending a data packet, the remote link adapter returns the credit control packet to a Hybridware™ server. A credit permits a remote link adapter to send a certain number of packets up to a maximum number controlled by a configuration parameter MAX_ CREDIT_ PACKETS, thereby eliminating polling for that period. If a remote link adapter does not have a data packet to send, it returns the credit to the hybrid access system without sending any data packets. The remote link adapter then sets a field in the credit control packet to the number of packets which was sent. If the protocol process at the server does not receive credit status information from the credit control packet within a certain credit time-out, CREDIT_TIMEOUT, in milliseconds, for a certain number of times, FAIL_CNT, consecutively, the remote link adapter is assumed to be in error and is put in a not-responding state. The overall upstream channel performance of a remote link adapter using a credit channel is lower than a remote link adapter on a sole use upstream channel. If any sole use upstream channel becomes available, this channel is given to the credit remote link adapter that has been waiting the longest for a sole use upstream channel that currently has packets to send.

Figure 18 is a flow diagram of information exchanges between Hybridware™ server and client, according to conditions in which the client has information to transmit and the server gradually allocates bandwidth to the client. In particular, a node first provides a single credit at a selected frequency. Then a packet is sent, consuming the credit, followed by a completion message indicating use of one credit and potential for an additional transmission corresponding to three credits. Next, a credit is provided corresponding to two packets at the selected frequency, which is followed by two packet transmissions and a completion message indicating consumption of two credits and potential for transmission of one more. In response, another double credit is sent, followed by a single packet and an acknowledgment of transmission of one and potential for no more transmissions.

Figure 19 is a flow diagram of information exchanges between Hybridware™ server and client, according to conditions in which the server allocates the client a dedicated channel, the client transmits data and periodically reports to the server with done messages. In particular, a credit indication dedicating a channel at frequency F is provided, followed by 235 packet transmissions. According to prearrangement, a operability indication in the form of a DONE message is provided at an established time indicating potential for five more packet transmissions. The done message indicates completion of 235 packet transmissions, as an

accounting function. Because the channel is dedicated, further packet transmissions are made without specific further credit allocations.

Figure 20 is a flow diagram of information exchanges between Hybridware™ server and client, according to conditions in which a dedicated channel is converted into a shared channel. In particular, a credit indication is provided, followed by transmission of 235 packets and a credit message stopping channel dedication and switching to a credit mode. Responsive to the credit message a DONE signal accounts for the 235 packets transmitted during the dedicated mode and indicates potential for five more transmissions. This is followed by a credit allocation of one at a selected frequency. Thus, one packet is transmitted, followed by a completion indication specifying potential for four more packets to be transmitted.

What is claimed is:

1. A hybrid access system for connecting at least a single client data processor with a network, comprising:

a local area network (LAN) system;

a hybrid system manager connected to said LAN system;

a downstream router connected to said LAN system for transmitting information;

an upstream router connected to said LAN system for receiving information, said upstream bridge router including a Hybridware™ server,

a broadcast unit connected to said downstream router;

a downstream channel connected to said broadcast unit for high speed transmission of information on said high speed downstream channel;

an independent upstream channel connected to said upstream router, which operates at a lower speed than said downstream channel;

at least a single remote link adapter connected to said upstream and downstream channels; and

a corresponding at least a single client data processor connected to said remote link adapter.

2. The hybrid access system according to claim 1, wherein said independent upstream channel includes a telephone network.

3. The hybrid access system according to claim 1, wherein said independent upstream channel includes a cable TV network.

4. The hybrid access system according to claim 1, wherein said independent upstream channel includes a wireless transmission path.

5. The hybrid access system according to claim 1, wherein said LAN system includes a LAN switch and a router.

6. The hybrid access system according to claim 1, wherein said broadcast unit includes at least one of a group consisting of a cable TV headend, a wireless TV transmitter, a satellite transmitter or a cell site.

7. A method of accessing a wide area network from any of a plurality of client processors each connected to an asymmetric hybrid network including high-speed downstream and lower-speed upstream channels controlled by a hybrid system manager and a router server, including the steps of:

providing a polling signal from a hybrid system manager to client processors,

issuing an upstream channel connection request by lower speed channel, if no upstream data channel is currently assigned to a client data processor,

conducting login communications between the router server and the system manager,

verifying authorized user status at the system manager level,

allocating an upstream channel by high speed downstream channel message, and

sending upstream data over the allocated lower speed upstream channel of the asymmetric hybrid access network.

8. The method according to claim 7, wherein providing a polling signal includes polling clients in an idle state at a selected frequency level of polling.

9. The method according to claim 7, wherein providing a polling signal includes polling clients in a blocked state at a selected frequency level of polling.

10. The method according to claim 7, wherein providing a polling signal includes polling clients in a non-responsive state at a selected frequency level of polling.

11. The method according to claim 7, wherein providing a polling signal includes polling clients in idle and blocked states at selected first and second frequency levels of polling, and polling of clients in an idle state occurs more frequently than polling of clients in a blocked state.

12. The method according to claim 7, wherein providing a polling signal includes polling clients in idle and non-responsive states at selected first and second frequency levels of polling, and polling of clients in an idle state occurs more frequently than polling of clients in a non-responsive state.

13. The method according to claim 7, wherein idle clients are polled multiple times during a poll cycle and polling of blocked and non_resp clients is distributed evenly over a poll cycle to assure that the latency for acquiring a channel for idle units is uniform.

14. The method according to claim 7, wherein polling includes grouping clients by state and polling within each group round robin.

15. A method of high speed remote access of a wide area network from any of a plurality of client processors each connected to an asymmetric hybrid network including high-speed downstream and lower-speed upstream channels controlled by a hybrid system manager and a router server, including the steps of:

issuing an upstream channel authorization request by lower speed channel, for upstream data channel currently used by a particular client data processor,

conducting login communications between the router server and the system manager,

verifying authorized user status at the system manager level,

authorizing specific upstream channel use by high speed downstream channel message, and

sending upstream data over the allocated lower speed upstream channel of the asymmetric hybrid access network.

16. A method of high speed remote access of a wide area network from any of a plurality of client processors each connected to an asymmetric hybrid network including high-speed downstream and lower-speed upstream channels controlled by a hybrid system manager and a router server, including the steps of:

sending a new client message to a plurality of hybrid routers, which provides client names,

broadcasting a poll message to a plurality of clients using client names,

recognizing a client name,

providing a poll response,

receiving a poll response,

reporting a client found to a system manager,

ceasing polling,

providing an address to the client which responded to poll,

receiving the address sent, and

configuring the client with the address provided.

17. A method of transmitting data from an upstream transmit queue in an upstream transmitter node to a selected receiver node, comprising the steps of:

transmitting selected amounts of data from a transmit queue in a first node to a second node,

generating acknowledgments of data received by said second node,

eliminating from the transmit queue of the second node data acknowledgments which are redundant of other acknowledgments in said second transmit queue, and

filling open transmit queue spaces with additional data.

18. A method of determining polling frequency from an upstream communications mode of a hybrid access system with respect to a plurality of downstream nodes having polling status levels corresponding to activity states in which a remote link adapter may be set, comprising the steps of:

determining the priority status of predetermined remote link adapters in a hybrid access system; and

polling the remote link adapter having the highest priority status level.

19. A method of setting remote link adapter power level in a hybrid access system, comprising the steps of:

transmitting successive indications to a hybrid upstream router at selected different power levels,

confirming receipt of a first power level indication, and

setting the level of future transmissions to a power associated with confirmation of receipt.

20. A method of packet suppression in communication between first and second nodes having respective first and second transmit and receive queues, in which information packets having headers are transmitted from said first node to said second node, comprising the steps of:

loading the transmit queue of said first node with a first information packet;

loading a second information packet into the transmit queue of said first node;

checking the headers of said first and second information packets, and

suppressing one of said first and second information packets, if the headers are the same.

21. A method of credit administration between first and second computer nodes, for information amounts having predetermined information credit values, comprising the steps of:

sending a credit to a first computer node, which sets a response frequency;

receiving an information amount corresponding in value up to the amount of the credit received at said first computer node at said response frequency; and

sending a done signal to said second computer node indicative of the credit received less the amount of information received.

22. A method of operating a client node, comprising the steps of:

sending periodic operability indication messages during an active state,

receiving a poll message, and requesting channel connection.

23. A method of operating a server node, comprising the steps of:

receiving periodic operability indication messages during an active state,

sending a polling message, when a threshold interval has expired,

awaiting a poll response, and

entering a non-responsive state if response to polling is received.

24. A method of responding to detected quality levels in a communication channel, comprising the steps of:

detecting a quality characteristic with respect to a selected communication channel from a selected group of quality characteristics each which is defined by quantitative levels,

determining whether the quantitative level of the detected quality characteristic deviates with respect to a predefined norm, and

switching to another communication channel, if sufficient deviation is determined.

25. The method according to claim 25, wherein said group of quality characteristics includes time from last operability indication, signal to noise ratio, and error frequency.

AMENDED CLAIMS
[received by the International Bureau on 12 August 1996 (12.08.96); original claims 1-25 replaced by amended claims 1-37 (14 pages)]

1. A network communication system including a server, a plurality of remote clients and an information distribution facility for distributing information signals to said remote clients, said communication system comprising:

a downstream channel that is shared by said plurality of remote clients so as to enable said clients to receive high speed data packets from said server over a shared medium,

at least one independent upstream channel for enabling at least one of said remote clients to transmit lower speed return data packets to said server,

a hybrid access system including a network manager for interactively managing both transfers of data packets from said server to said remote clients via broadcasts over said shared medium in accordance with a high speed downstream channel protocol and transfers of lower speed return data packets from said remote clients to said server over said independent upstream channel in accordance with an upstream channel protocol, said network manager being operable to provide full-duplex point-to-multipoint communication between said server and said plurality of remote clients, and

said hybrid access system further includes a server interface that enables communication with said server, a downstream router for enabling transmission of high speed data packets to said remote clients over said shared medium and an upstream router for receiving return data packets from said remote clients.

2. A network communication system as recited in claim 1 wherein said plurality of remote clients includes remote link adapters and said downstream router couples said shared medium to establish a physical connection with said downstream channel and said upstream router couples said remote link adapters to establish a physical connection with said upstream channel.

3. A network communication system as recited in claim 1 wherein said independent upstream channel lies in a communication medium that is different from said downstream channel.

4. A network communication system as recited in claim 1 wherein said shared medium comprises a hybrid fiber coaxial cable and said remote clients physically connect in parallel to said hybrid fiber coaxial cable to receive simultaneously broadcasted data packets whereby to facilitate efficient sharing of resources at said distribution facility by said remote clients.

5. A network communication system as recited in claim 4 wherein said at least one independent upstream channel comprises a PSTN network that routes data packets transmitted by said at least one remote client to said information distribution facility which, in turn, routes said data packets to said server.

6. A network communication system as recited in claim 5 wherein said at least one independent upstream channel comprises a PSTN network that routes data packets transmitted by said at least one remote client directly to said server.

7. A network communication system as recited in claim 5 wherein said at least one independent upstream channel comprises an independent lower speed channel transmitted over said hybrid fiber coaxial cable, and said upstream router receives said data packets transmitted by said at least one remote client over said

independent upstream channel and routes said data packets to said server.

8. A network communication system as recited in claim 1 wherein said distribution facility comprises a cellular broadcast facility, said shared medium comprises radio frequency broadcasts from said cellular broadcast facility, and said remote clients each comprise radio frequency receivers for substantially simultaneously receiving data packets transmitted over said shared medium so as to provide sharing of resources at said distribution facility by said remote clients.

9. A network communication system as recited in claim 8 wherein said at least one independent upstream channel comprises a lower speed cellular return channel routed through said distribution facility.

10. A network communication system as recited in claim 1 wherein said distribution facility comprises a satellite, said shared medium comprises a direct satellite broadcast and said remote clients include a receiver for substantially simultaneously receiving information signals from said broadcast so as to provide sharing of broadcast resources among said remote clients.

11. A network communication system as recited in claim 10 wherein said at least one independent upstream channel comprises a PSTN network that routes data packets transmitted by said at least one remote client directly to said server.

12. A network communication system as recited in claim 1 wherein each of said upstream and downstream channels lies in a communication medium selected from one of a CATV distribution network, a cell site, an rf radio transmission, an rf television transmission, a hybrid fiber coaxial cable network, an over-the-

air wireless network, a direct broadcast satellite communication network and a telephone network.

13. A network communication system as recited in claim 1 wherein said distribution facility comprises a television broadcast facility, said shared medium comprises radio frequency broadcasts from said television broadcast facility, and said remote clients include radio frequency receivers for substantially simultaneously receiving data packets transmitted over said shared medium whereby to provide sharing of resources located at said distribution facility.

14. A network communication system as recited in claim 13 wherein said at least one independent upstream channel comprises a PSTN network that routes data packets transmitted by said at least one remote client to said information distribution facility which, in turn, routes said data packets to said server.

15. A network communication system as recited in claim 14 wherein said at least one independent upstream channel comprises a PSTN network that routes data packets transmitted by said at least one remote client directly to said server.

16. A network communication system as recited in claim 1 wherein said upstream channel protocol enables operation of said upstream channel at multiple speeds and said hybrid access system selectably controls speed of data transfers on said upstream channel so as to provide more effective utilization of channel bandwidth according to demand by respective remote clients communicating with said shared medium.

17. In an asymmetric network communication system including a host server and a plurality of remote clients wherein respective

AMENDED SHEET (ARTICLE 19)

remote clients have associated remote link adapters that operate in accordance with predefined downstream and upstream protocols, the improvement comprising:

a headend facility that distributes information signals,

a downstream channel that is shared by said plurality of remote clients so as to permit said plurality of remote clients to receive high speed information signals from said host server over a shared medium,

at least one upstream channel that is independent of said downstream channel to enable at least one of said remote clients to transmit return information signals to said host server at a lower speed than said information signals transmitted over said downstream channel,

a hybrid access system for controlling transfers of information signals transmitted from said host server to said remote clients over said shared medium in accordance with said downstream protocol and for monitoring communication over said independent upstream channels thereby to provide interactive communication between said host server and at least one of said plurality of remote clients over said downstream and upstream communication channels, and

said hybrid access system further including a backbone interface that enables connection with said host server and a downstream router for enabling transmission of high speed information to said remote clients over said shared media,

whereby said asymmetric network communication system provides full-duplex interactive asymmetric communication between a host server and said at least one of said plurality of remote clients in a shared medium environment.

18. A packet delivery system for use in an asymmetric network to provide full-duplex communication, said system including a host server and at least one remote client that has a remote link adapter operating in accordance with a high speed downstream and a lower speed upstream protocol, said packet delivery system comprising:

a downstream channel that is shared by said at least one remote client so as to enable said at least one remote client to receive high speed data packets from said host server over a shared medium,

at least one independent upstream channel that enables said remote client to transmit lower speed return data packets to said host server,

a hybrid access system for controlling transfers of data packets from said host server to said remote client over said shared medium in accordance with said downstream channel protocol and for monitoring communication over said independent upstream channel thereby to schedule upstream communication in accordance with predefined rules, and

said hybrid access system further including an interface that enables connection with said host server and a downstream router for enabling transmission of high speed data packets to said remote client over said shared media.

19. A packet delivery system as recited in claim 18 wherein said hybrid access system effects control of assignment of upstream channels to said remote client so as to assign either a shared channel or dedicated channel to a remote client.

20. A packet delivery system as recited in claim 19 wherein said hybrid access system effects switching of channel assignments among said remote clients between shared and dedicated upstream channels.

21. In a wide area network that includes a host server, a plurality of remote clients, a headend facility, a high speed interface that connects said headend facility with said host server, and a high speed link for transferring downstream data packets, a method of providing high speed remote access from any of a plurality of client processors each connected to said asymmetric network including high-speed downstream and lower-speed upstream channels controlled by a hybrid system manager and a router, said method including the steps of:

providing a downstream channel that is shared by said plurality of remote clients over a shared medium,

providing at least one independent upstream channel that enables at least one of said remote clients to transmit lower speed return data packets to said host server over an upstream channel that is independent of said downstream channel,

issuing an upstream channel authorization request by a lower speed channel for an upstream data channel currently used by a particular client data processor,

conducting login communications between the router and the system manager,

verifying authorized user status at the system manager,

authorizing specific upstream channel use by high speed downstream channel message transmitted over said downstream channel, and

sending upstream data over an allocated lower speed upstream channel of the asymmetric network.

22. In a full-duplex asymmetric network communication system for transferring information between a host server and a plurality of remote clients over a shared medium and wherein said remote clients include respective remote link adapters for receiving high speed downstream information from said host server over said shared medium and for transmitting lower speed return information over an upstream channel that is independent of said downstream channel, and wherein said network communication system includes a hybrid access system for providing interactive network sessions in downstream and upstream communication channels, a method of transmitting data from an upstream transmit queue in an upstream transmitter node to a selected receiver node located at a receiving end, said method comprising the steps of:

transmitting selected amounts of packet data from a transmit queue in a first node to a second node wherein said second node includes a transmit queue for transmitting acknowledgments to a receiver node,

generating acknowledgments of packet data received by said second node,

eliminating from the transmit queue of the second node packet data acknowledgments which are redundant of other packet data acknowledgments in said second transmit queue, and

filling open transmit queue spaces with additional packet data.

23. In a full-duplex asymmetric network communication system for transferring information between a host server and a plurality of remote clients over a shared medium and wherein said remote clients include respective remote link adapters for receiving high speed downstream information from said host server over said shared medium and for transmitting lower speed return information over an upstream channel that is independent of said downstream channel, and wherein said network communication system includes a hybrid access system for providing an interactive network session in downstream and upstream communication channels, a method of dynamically setting remote link adapter power levels in said hybrid access system comprising the steps of:

transmitting successive indications to a hybrid upstream router at selected different power levels,

confirming receipt of a selected one of said indications, and

setting a level of future transmissions to a power level associated the selected indication.

24. In a full-duplex asymmetric network communication system for transferring information from a host server and a plurality of remote clients over a shared medium and wherein said remote clients include respective remote link adapters for receiving high speed downstream information from said host server over said shared medium and for transmitting lower speed return information over an upstream channel that is independent of said downstream channel, and wherein said network communication system includes a hybrid access system for providing interactive network sessions in downstream and upstream communication channels, a method of packet suppression in communication between first and second nodes in said communication system having respective first and

second transmit and receive queues, in which information packets having headers are transmitted from said first node to said second node, comprising the steps of:

loading a first information packet into the transmit queue of said first node;

loading a second information packet into the transmit queue of said first node;

checking the headers of said first and second information packets, and responsive to redundancy between said first and second headers, suppressing one of said first and second information packets.

25. In a full-duplex asymmetric network communication system for transferring information from a host server and a plurality of remote clients over a shared medium and wherein said remote clients include respective remote link adapters for receiving high speed downstream information from said host server over said shared medium and for transmitting lower speed return information over an upstream channel that is independent of said downstream channel, and wherein said network communication system includes a hybrid access system for simultaneously controlling the downstream and upstream in interactive network sessions, a method of dynamically responding to detected quality levels in a communication channel comprising the steps of:

detecting a quality characteristic with respect to a selected communication channel from a selected group of quality characteristics each of which is defined by quantitative levels,

determining whether the quantitative level of the detected quality characteristic deviates with respect to a predefined norm, and

dynamically switching to another communication channel, if sufficient deviation is determined.

26. The method according to claim 25 wherein said group of quality characteristics includes time from last operability indication, signal to noise ratio, and error frequency.

27. A method of accessing a wide area network from any of a plurality of client processors in communication with an asymmetric hybrid network over a shared medium wherein said communication occurs over a high-speed downstream channel and a lower speed upstream channel managed by a hybrid system manager and a router server, including the steps of:

providing a polling signal from a hybrid system manager to poll a plurality of client processors,

issuing an upstream channel connection request via a lower speed channel from one of said client processors, if no upstream data channel is currently assigned to said client data processor,

conducting login communications between the router server and the system manager with respect to said client processor,

verifying authorized user status of said client processor at the system manager level,

allocating an upstream channel to said client processor via a high speed downstream channel message, and

sending upstream data from said client processor over the allocated lower speed channel of the asymmetric hybrid access network.

28. The method according to claim 27, wherein providing a polling signal includes pooling clients in a idle state at a selected frequency level of polling.

29. The method according to claim 27, wherein providing said polling step includes polling clients in a blocked state at a selected level of polling.

30. The method according to claim 27, wherein providing said polling step includes polling clients in a non-responsive state at a selected frequency level of polling.

31. The method according to claim 27, wherein providing said polling step includes polling clients in idle and blocked states at selected first and second frequency levels of polling, and polling of clients in a idle state occurs more frequently than polling of clients in a blocked state.

32. The method according to claim 27, wherein providing said polling step includes polling clients in idle and non-responsive states at selected first and second frequency levels of polling, and polling of clients in an idle state occurs more frequently than polling of clients in a non-responsive state.

33. The method as recited in claim 27, wherein idle clients are polled multiple times during a poll cycle and polling of blocked and non_resp clients is distributed evenly over a poll cycle to assure that the latency for acquiring a channel for idles units is uniform.

34. The method as recited in claim 27, wherein polling includes grouping clients by state and polling within each group on a round-robin basis.

35. A method of high-speed remote access in a wide area network from any one of a plurality of client processors in communication with an asymmetric hybrid network over a shared medium wherein said communication occurs over a high speed downstream channel

and a lower speed upstream channel managed by a hybrid system manager, including the steps of:

sending a new client message to a plurality of hybrid routers that provide client names,

broadcasting a poll message to a plurality of clients using client names,

recognizing a client name,

providing a poll response,

receiving a poll response,

reporting a client found to a system manager,

reporting a client found message to a system manager,

ceasing broadcasting said poll message,

providing an address to the client which responded to the broadcast,

receiving the address sent by said client, and

configuring said client with the address provided.

36. A method of polling client processors at varying frequencies from an upstream communications node of a hybrid access system having a plurality of downstream nodes, comprising the steps of:

providing a number of activity states of said client processors associated with different states of operation of an associated remote link adapter to which said client device is connected,

assigning a polling frequency of said client processors according to said activity states,

determining a polling frequency of said client processors according to respective activity states of said client processors, and

polling respective groups of client processors at respective assigned polling frequencies according to activity states of respective groups of client devices.

37. A method of administering transmission credits between first and second nodes in a communications system wherein a transmission credit value enables said first node to transmit a fixed amount of information, comprising the steps of:

allocating a transmission credit value and sending said allocated credit value to a first node,

responsive to said credit value, transmitting on an available channel an amount of information from said first node to said second node in accordance with the credit value,

receiving an amount of information corresponding in value up to the amount of the transmission credit value, and

sending a done signal from said first node to said second node indicative of the credit value allocated less the amount of information received.

STATEMENT UNDER ARTICLE 19

New claims 1-21 better define the invention over prior art references of Litteral et al. and Wheeler et al. In particular, the new claims characterize the invention as including a network manager (e.g., hybrid access system) that utilizes a point-to-multipoint shared medium architecture over which a host server communicates with a plurality of remote clients in an asymmetric and interactive communication network. This differs from the point-to-point ADSL bridge architecture (e.g., hub and spoke structure) of Litteral et al. that requires dedicated links between the ADSL bridge and each remote client. Alternatively, a "shared media" system permits multiple users to share common headend resources through a "parallel" or over-the-air coupling. It is noted that Wheeler et al. disclose a medium that is locally shared (e.g., a conventional LAN), as opposed to a host-to-remote shared medium, but even Wheeler et al.'s medium lacks both asymmetry operation and a network manager having the claimed structure to provide the claimed functionality.

Specific functionality provided by the shared medium architecture enables a network manager to provide more efficient sharing of resources and scalability in number of clients, interactive management of downstream and upstream data flow, switching between shared and dedicated logical upstream channels to better match bandwidth demand, assignment of optimum speeds of upstream data rate to respective clients (e.g, bandwidth on demand) based on available upstream bandwidth, as well as, other advantages. Such shared medium architecture for providing split-channel asymmetric interactive full-duplex communication in which remote clients essentially are connected in parallel is not disclosed in any of the cited references.

Apart from differences mentioned above, new claims 22-26 define other features of the invention over McMullan et al. In particular, McMullan et al. fail to show a transmit queue at that transmitting end which enqueues data packets (or acknowledgments) from which redundant packets (or acknowledgments) about to be transmitted are removed from the transmit queue before they are actually transmitted in accordance with acknowledgments received from a transmitter located at a receiving end. McMullan et al. merely show suppression operations at a receiving end and not interactivity between a transmitting and receiving end to remove redundancy of information in a transmit queue. Also, McMullan et al. do not show use of such suppression techniques in a shared medium point-to-multipoint environment as provided by the new claims. Aside from the absence of an interactive network McMullan et al. also do not show "dynamic" calibration of power based on "successive" transmission of different power levels as recited in new claim 23. Instead, McMullan et al. show "manual" power calibration. Further, McMullan et al. do not disclose feedback control of power or other parameters based on a quality characteristic such as a "last operability indication", "signal-to-noise ratio" or "error frequency" as recited in claim 26.

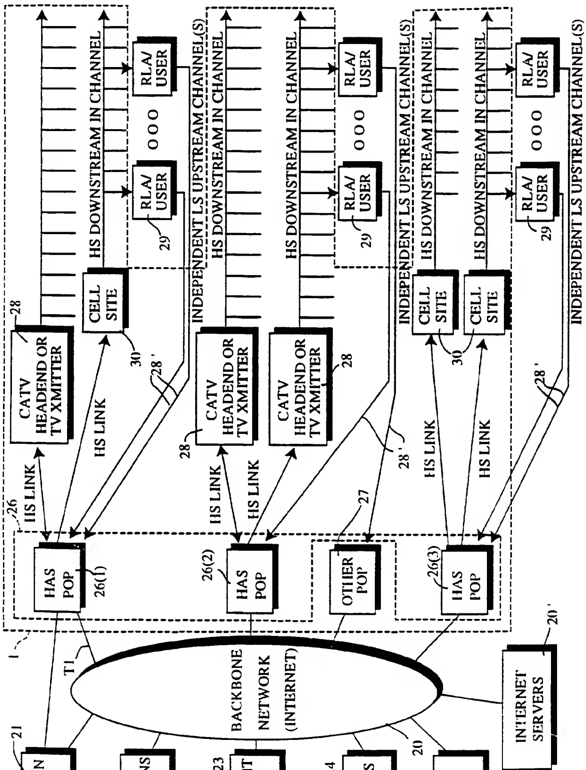

INFORMATION PROVIDERS
CORPORATIONS
GOVERNMENT AGENCIES
UNIVERSITIES
OTHER
INTERNET SERVERS
BACKBONE NETWORK (INTERNET)
T1
HAS POP
OTHER POP
CATV HEADEND OR TV XMITTER
CELL SITE
RLA/ USER
HS LINK
HS DOWNSTREAM IN CHANNEL
INDEPENDENT LS UPSTREAM CHANNEL(S)
21
22
23
24
25
20
20'
26
26(1)
26(2)
26(3)
27
28
28'
29
30

FIGURE 1

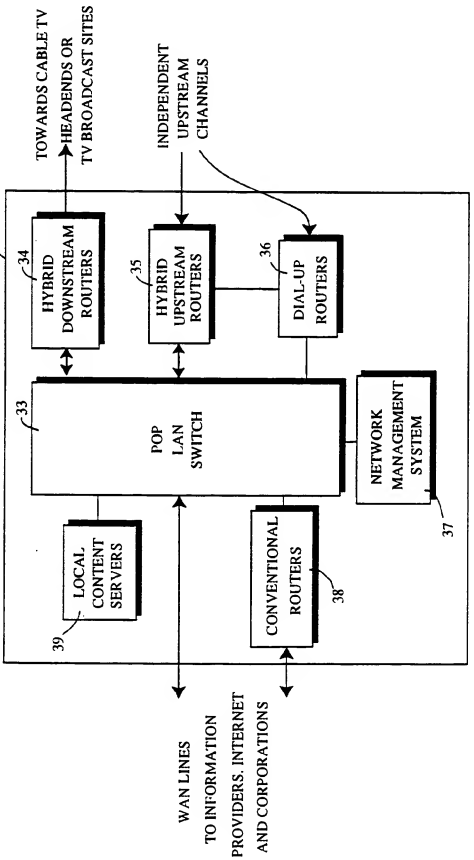

TOWARDS CABLE TV
HEADENDS OR
TV BROADCAST SITES
INDEPENDENT
UPSTREAM
CHANNELS
26(1)
34
HYBRID
DOWNSTREAM
ROUTERS
35
HYBRID
UPSTREAM
ROUTERS
36
DIAL-UP
ROUTERS
33
POP
LAN
SWITCH
NETWORK
MANAGEMENT
SYSTEM
37
LOCAL
CONTENT
SERVERS
39
CONVENTIONAL
ROUTERS
38
WAN LINES
TO INFORMATION
PROVIDERS, INTERNET
AND CORPORATIONS

FIGURE 2a

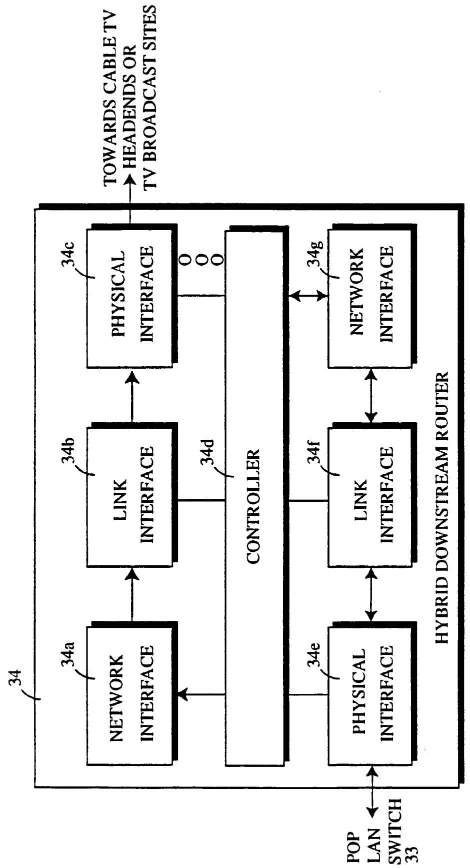

TOWARDS CABLE TV HEADENDS OR TV BROADCAST SITES
34
34a
NETWORK INTERFACE
34b
LINK INTERFACE
34c
PHYSICAL INTERFACE
34d
CONTROLLER
34e
PHYSICAL INTERFACE
34f
LINK INTERFACE
34g
NETWORK INTERFACE
HYBRID DOWNSTREAM ROUTER
POP LAN SWITCH 33

FIGURE 2b

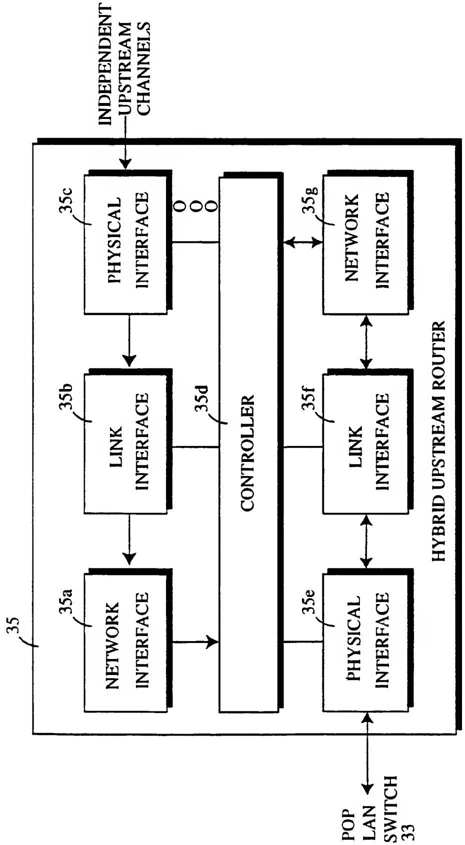

INDEPENDENT UPSTREAM CHANNELS
35c
PHYSICAL INTERFACE
35b
LINK INTERFACE
35a
NETWORK INTERFACE
35d
CONTROLLER
35g
NETWORK INTERFACE
35f
LINK INTERFACE
35e
PHYSICAL INTERFACE
35
HYBRID UPSTREAM ROUTER
POP LAN SWITCH 33

FIGURE 2c

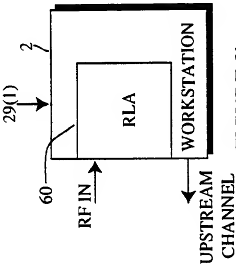


FIGURE 3b

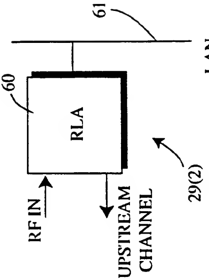


FIGURE 3c

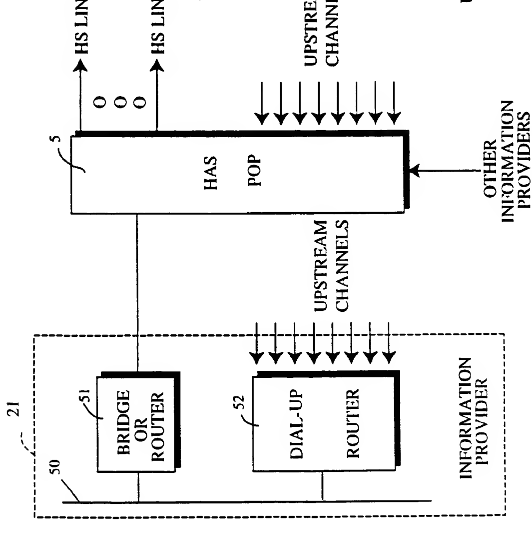


FIGURE 3a

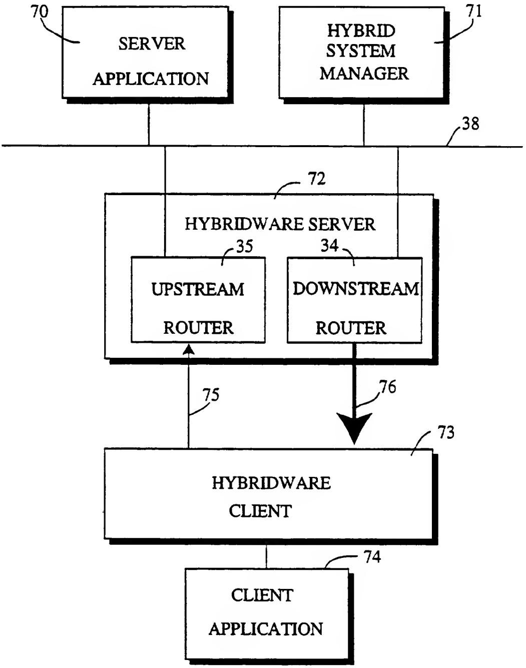

70
SERVER
APPLICATION
71
HYBRID
SYSTEM
MANAGER
38
72
HYBRIDWARE SERVER
35
34
UPSTREAM
ROUTER
DOWNSTREAM
ROUTER
75
76
73
HYBRIDWARE
CLIENT
74
CLIENT
APPLICATION

FIGURE 4

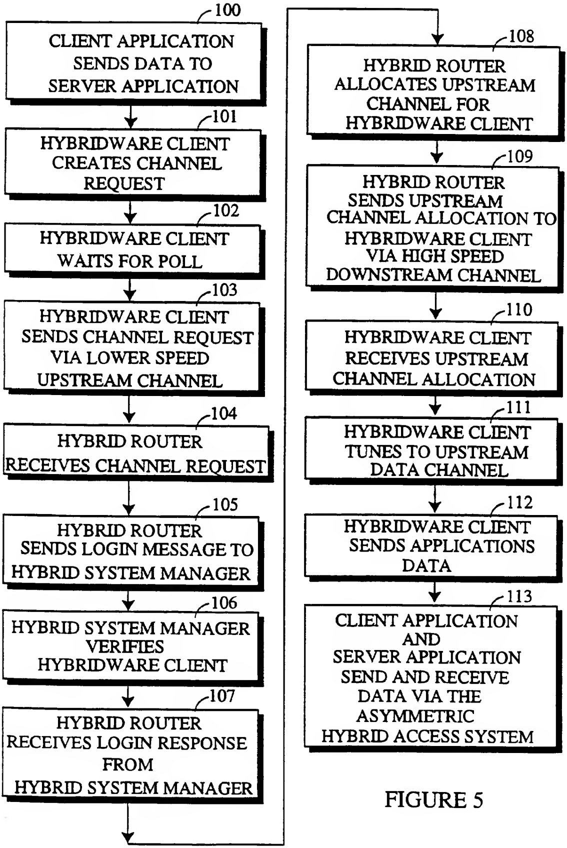

100
CLIENT APPLICATION SENDS DATA TO SERVER APPLICATION
101
HYBRIDWARE CLIENT CREATES CHANNEL REQUEST
102
HYBRIDWARE CLIENT WAITS FOR POLL
103
HYBRIDWARE CLIENT SENDS CHANNEL REQUEST VIA LOWER SPEED UPSTREAM CHANNEL
104
HYBRID ROUTER RECEIVES CHANNEL REQUEST
105
HYBRID ROUTER SENDS LOGIN MESSAGE TO HYBRID SYSTEM MANAGER
106
HYBRID SYSTEM MANAGER VERIFIES HYBRIDWARE CLIENT
107
HYBRID ROUTER RECEIVES LOGIN RESPONSE FROM HYBRID SYSTEM MANAGER
108
HYBRID ROUTER ALLOCATES UPSTREAM CHANNEL FOR HYBRIDWARE CLIENT
109
HYBRID ROUTER SENDS UPSTREAM CHANNEL ALLOCATION TO HYBRIDWARE CLIENT VIA HIGH SPEED DOWNSTREAM CHANNEL
110
HYBRIDWARE CLIENT RECEIVES UPSTREAM CHANNEL ALLOCATION
111
HYBRIDWARE CLIENT TUNES TO UPSTREAM DATA CHANNEL
112
HYBRIDWARE CLIENT SENDS APPLICATIONS DATA
113
CLIENT APPLICATION AND SERVER APPLICATION SEND AND RECEIVE DATA VIA THE ASYMMETRIC HYBRID ACCESS SYSTEM

FIGURE 5

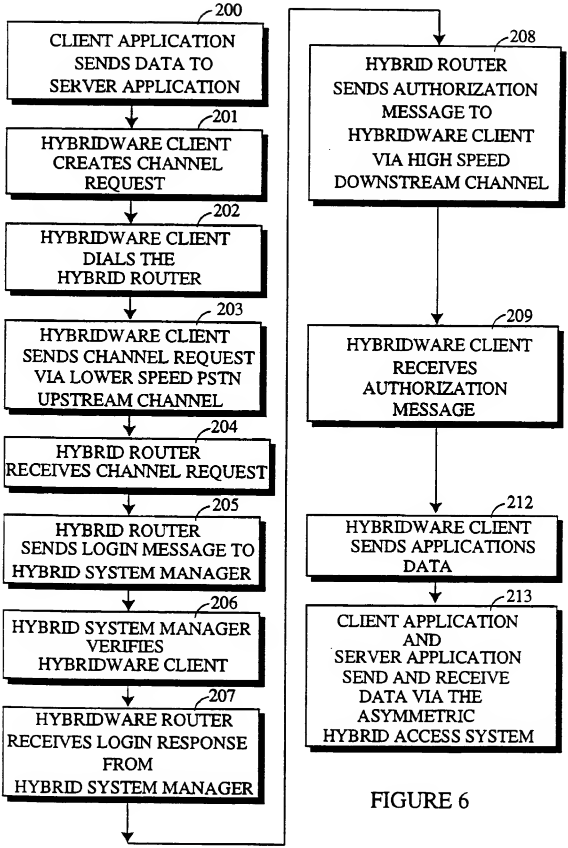

200
CLIENT APPLICATION SENDS DATA TO SERVER APPLICATION
201
HYBRIDWARE CLIENT CREATES CHANNEL REQUEST
202
HYBRIDWARE CLIENT DIALS THE HYBRID ROUTER
203
HYBRIDWARE CLIENT SENDS CHANNEL REQUEST VIA LOWER SPEED PSTN UPSTREAM CHANNEL
204
HYBRID ROUTER RECEIVES CHANNEL REQUEST
205
HYBRID ROUTER SENDS LOGIN MESSAGE TO HYBRID SYSTEM MANAGER
206
HYBRID SYSTEM MANAGER VERIFIES HYBRIDWARE CLIENT
207
HYBRIDWARE ROUTER RECEIVES LOGIN RESPONSE FROM HYBRID SYSTEM MANAGER
208
HYBRID ROUTER SENDS AUTHORIZATION MESSAGE TO HYBRIDWARE CLIENT VIA HIGH SPEED DOWNSTREAM CHANNEL
209
HYBRIDWARE CLIENT RECEIVES AUTHORIZATION MESSAGE
212
HYBRIDWARE CLIENT SENDS APPLICATIONS DATA
213
CLIENT APPLICATION AND SERVER APPLICATION SEND AND RECEIVE DATA VIA THE ASYMMETRIC HYBRID ACCESS SYSTEM

FIGURE 6

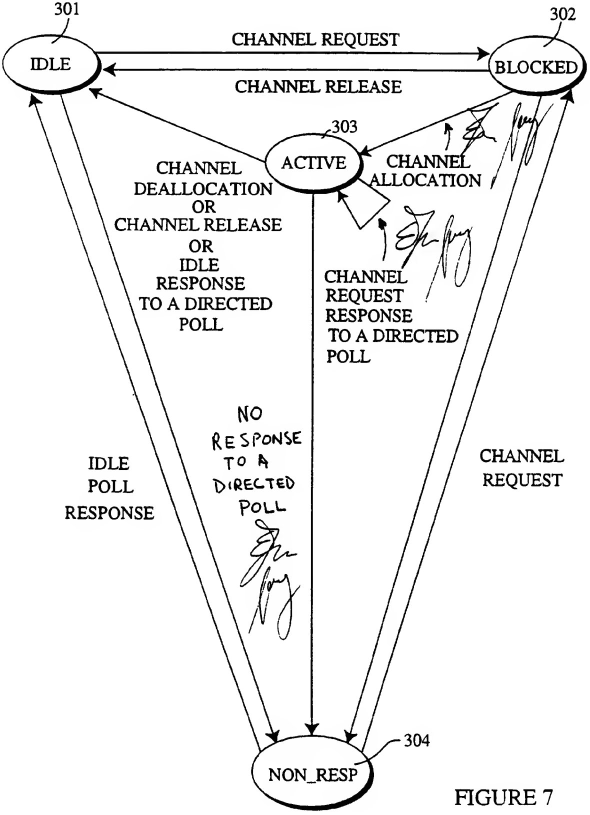

301
302
IDLE
CHANNEL REQUEST
CHANNEL RELEASE
BLOCKED
303
ACTIVE
CHANNEL DEALLOCATION OR CHANNEL RELEASE OR IDLE RESPONSE TO A DIRECTED POLL
CHANNEL ALLOCATION
CHANNEL REQUEST RESPONSE TO A DIRECTED POLL
NO RESPONSE TO A DIRECTED POLL
IDLE POLL RESPONSE
CHANNEL REQUEST
304
NON_RESP

FIGURE 7

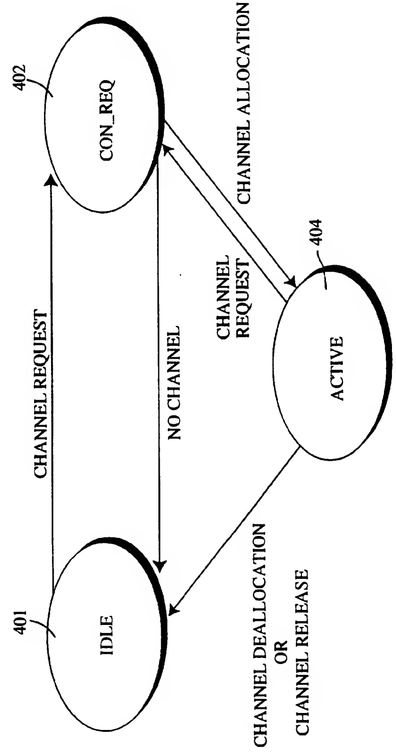

402
CON_REQ
CHANNEL ALLOCATION
CHANNEL REQUEST
NO CHANNEL
CHANNEL REQUEST
404
ACTIVE
401
IDLE
CHANNEL DEALLOCATION
OR
CHANNEL RELEASE

FIGURE 8

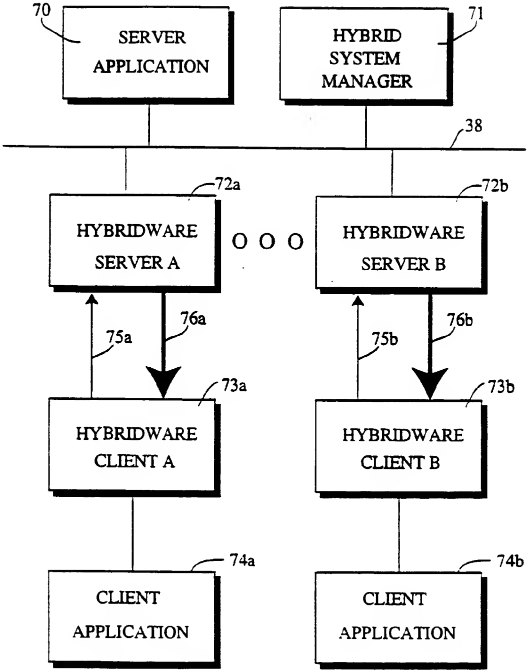

70
SERVER
APPLICATION
HYBRID
SYSTEM
MANAGER
71
38
72a
HYBRIDWARE
SERVER A
O O O
72b
HYBRIDWARE
SERVER B
76a
75a
76b
75b
73a
HYBRIDWARE
CLIENT A
73b
HYBRIDWARE
CLIENT B
74a
CLIENT
APPLICATION
74b
CLIENT
APPLICATION

FIGURE 9

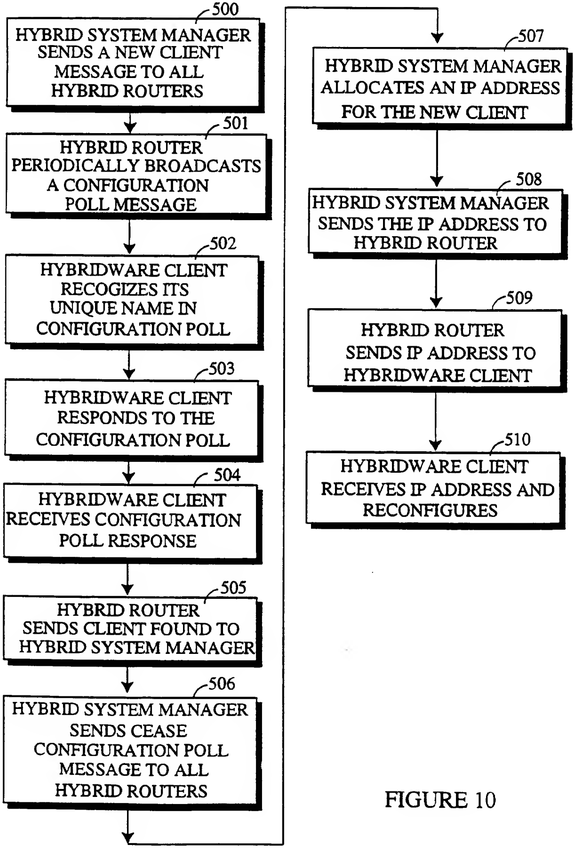

500
HYBRID SYSTEM MANAGER SENDS A NEW CLIENT MESSAGE TO ALL HYBRID ROUTERS
501
HYBRID ROUTER PERIODICALLY BROADCASTS A CONFIGURATION POLL MESSAGE
502
HYBRIDWARE CLIENT RECOGIZES ITS UNIQUE NAME IN CONFIGURATION POLL
503
HYBRIDWARE CLIENT RESPONDS TO THE CONFIGURATION POLL
504
HYBRIDWARE CLIENT RECEIVES CONFIGURATION POLL RESPONSE
505
HYBRID ROUTER SENDS CLIENT FOUND TO HYBRID SYSTEM MANAGER
506
HYBRID SYSTEM MANAGER SENDS CEASE CONFIGURATION POLL MESSAGE TO ALL HYBRID ROUTERS
507
HYBRID SYSTEM MANAGER ALLOCATES AN IP ADDRESS FOR THE NEW CLIENT
508
HYBRID SYSTEM MANAGER SENDS THE IP ADDRESS TO HYBRID ROUTER
509
HYBRID ROUTER SENDS IP ADDRESS TO HYBRIDWARE CLIENT
510
HYBRIDWARE CLIENT RECEIVES IP ADDRESS AND RECONFIGURES

FIGURE 10

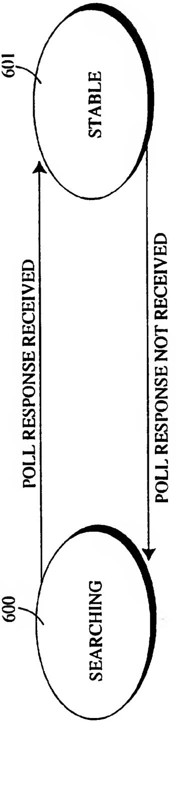

601
STABLE
POLL RESPONSE RECEIVED
POLL RESPONSE NOT RECEIVED
600
SEARCHING

FIGURE 11

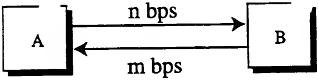


FIGURE 12a
PRIOR ART

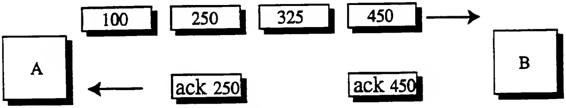


FIGURE 12b
PRIOR ART

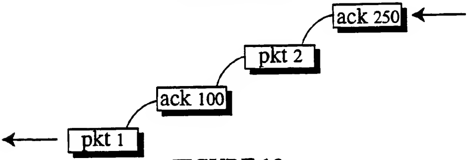


FIGURE 12c

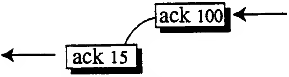


FIGURE 12d

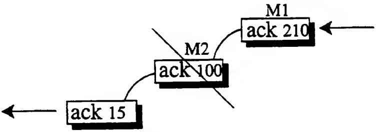


FIGURE 12e

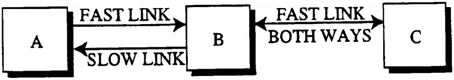


FIGURE 12f

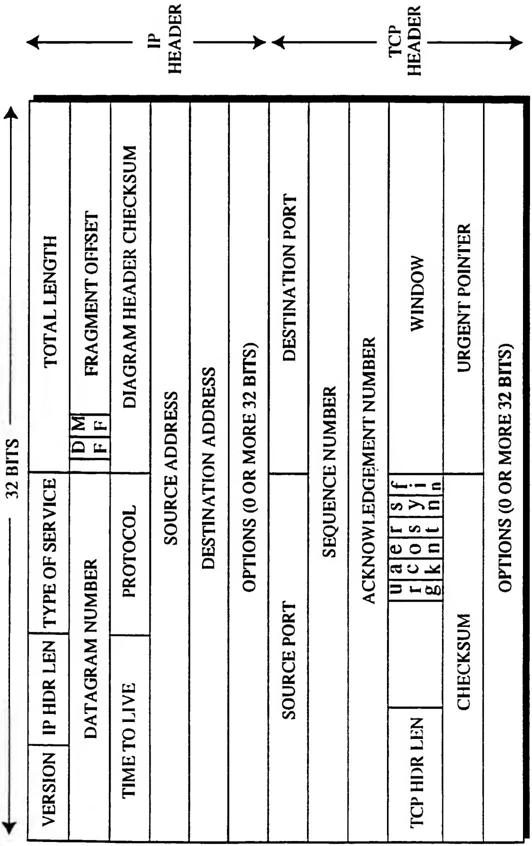

IP HEADER
TCP HEADER
32 BITS
VERSION
IP HDR LEN
TYPE OF SERVICE
TOTAL LENGTH
DATAGRAM NUMBER
D F
M F
FRAGMENT OFFSET
TIME TO LIVE
PROTOCOL
DIAGRAM HEADER CHECKSUM
SOURCE ADDRESS
DESTINATION ADDRESS
OPTIONS (0 OR MORE 32 BITS)
SOURCE PORT
DESTINATION PORT
SEQUENCE NUMBER
ACKNOWLEDGEMENT NUMBER
TCP HDR LEN
u r g
a c k
e o n
r s t
s y n
f i n
WINDOW
CHECKSUM
URGENT POINTER
OPTIONS (0 OR MORE 32 BITS)

FIGURE 13

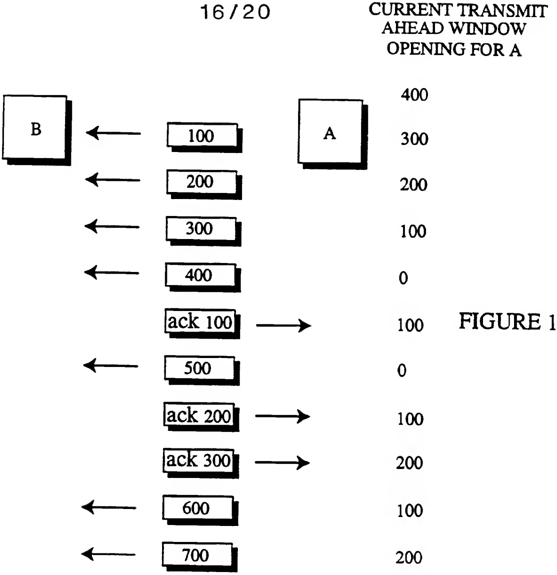


FIGURE 14a

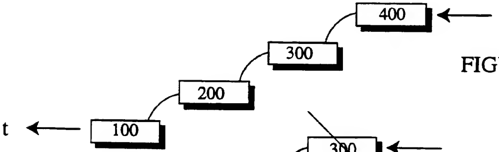


FIGURE 14b

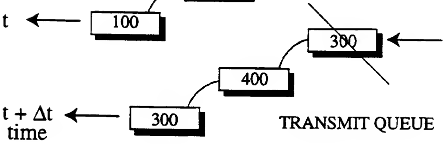


FIGURE 14c

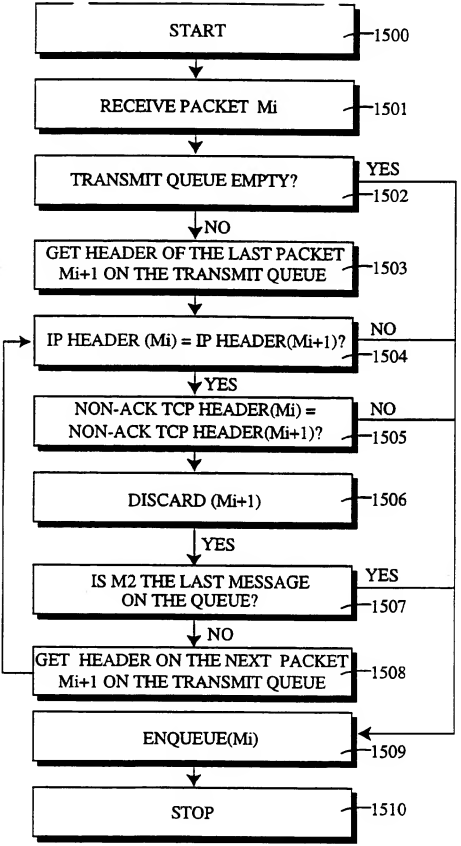

START
1500
RECEIVE PACKET Mi
1501
TRANSMIT QUEUE EMPTY?
YES
1502
NO
GET HEADER OF THE LAST PACKET Mi+1 ON THE TRANSMIT QUEUE
1503
IP HEADER (Mi) = IP HEADER(Mi+1)?
NO
1504
YES
NON-ACK TCP HEADER(Mi) = NON-ACK TCP HEADER(Mi+1)?
NO
1505
DISCARD (Mi+1)
1506
YES
IS M2 THE LAST MESSAGE ON THE QUEUE?
YES
1507
NO
GET HEADER ON THE NEXT PACKET Mi+1 ON THE TRANSMIT QUEUE
1508
ENQUEUE(Mi)
1509
STOP
1510

FIGURE 15

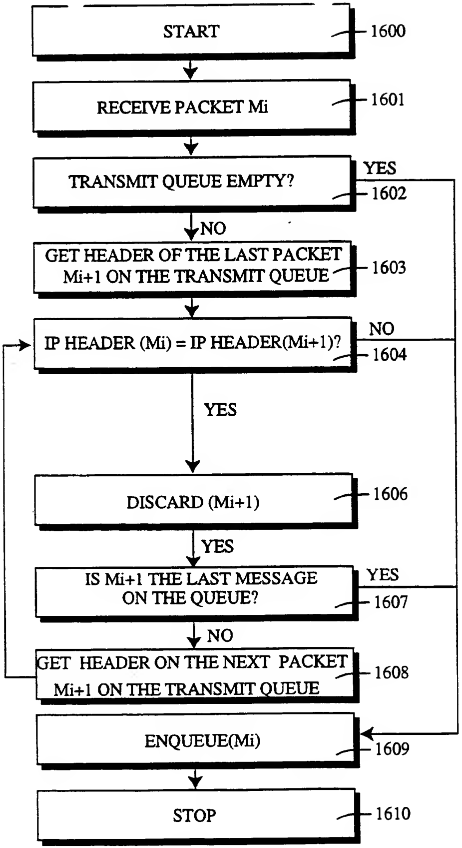

START
1600
RECEIVE PACKET Mi
1601
TRANSMIT QUEUE EMPTY?
YES
1602
NO
GET HEADER OF THE LAST PACKET Mi+1 ON THE TRANSMIT QUEUE
1603
IP HEADER (Mi) = IP HEADER(Mi+1)?
NO
1604
YES
DISCARD (Mi+1)
1606
YES
IS Mi+1 THE LAST MESSAGE ON THE QUEUE?
YES
1607
NO
GET HEADER ON THE NEXT PACKET Mi+1 ON THE TRANSMIT QUEUE
1608
ENQUEUE(Mi)
1609
STOP
1610

FIGURE 16

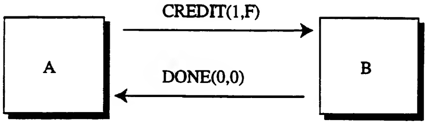


FIGURE 17

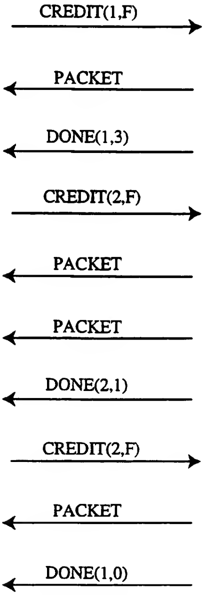


FIGURE 18

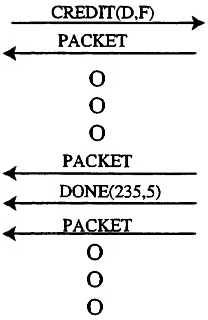


FIGURE 19

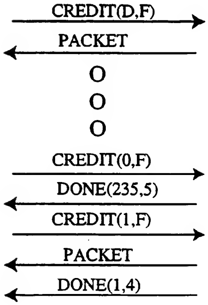


FIGURE 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/05453

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :Please See Extra Sheet.
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/37, 60, 61, 85.6, 85.13, 94.1, 95.2; 379/96, 97, 98, 105; 348/12; 455/5.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,142,690 (MCMULLAN, JR. ET AL.) 25 AUGUST 1992, col. 29, line 39 to col. 30, line 16, col. 46, lines 46-61, col. 15, line 59 to col. 16, line 2, and col. 49, lines 35-50.	17, 19, 20, 24, 25
Y	US, A, 5,247,347 (LITTERAL ET AL.) 21 SEPTEMBER 1993, col. 5, line 57 to col. 6, line 30, col. 8, line 60 to col. 9, line 12, col. 10, lines 47-68, Figs. 1 and 2.	1-6, 15
Y	US, A, 5,200,993 (WHEELER ET AL.) 06 APRIL 1993, col. 7, line 52 to col. 8, line 2.	1-6, 15
A	US, A, 5,347,304 (MOURA ET AL.) 13 SEPTEMBER 1994, see entire document.	1-25

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 MAY 1996	12 JUN 1996

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Douglas Olms
Facsimile No. (703) 305-3230	Telephone No. (703) 305-4703

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/05453

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,499,568 (GREMILLET) 12 February 1985, see entire document.	1-25
A	US, A, 5,327,554 (PALAZZI, III ET AL.) 05 July 1994, see entire document.	1-25
A,P	US, A, 5,450,123 (SMITH) 12 September 1995, see entire document.	1-25
A,P	US, A, 5490,141 (LAI ET AL.) 06 February 1996, see entire document.	1-25
Y	US, A, 4,168,532 (DEMPSEY ET AL.) 18 SEPTEMBER 1979, col. 4, lines 18-50 and col. 5, line 41 to col. 6, line 6.	7-14, 16, 18, 21-23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/05453

A. CLASSIFICATION OF SUBJECT MATTER:
IPC (6):

H04J 3/02, 3/24, 15/00; H04Q 11/04; H04M 11/00; H04H 1/00; H04N 7/10

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

370/37, 60, 61, 85.13, 94.1, 95.2; 379/96, 97, 98, 105; 348/12; 455/5.1

B. FIELDS SEARCHED
Electronic data bases consulted (Name of data base and where practicable terms used):

APS, INTERNET, DIALOG
search terms: local area network, wide area network, internet, high speed channel, cell, wireless, television, satellite, low speed channel, cable, Hybrid, Hybridware, broadcast, full-duplex, manager, router, remote channel, polling, priority